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Washing Machine

Finite State Machine

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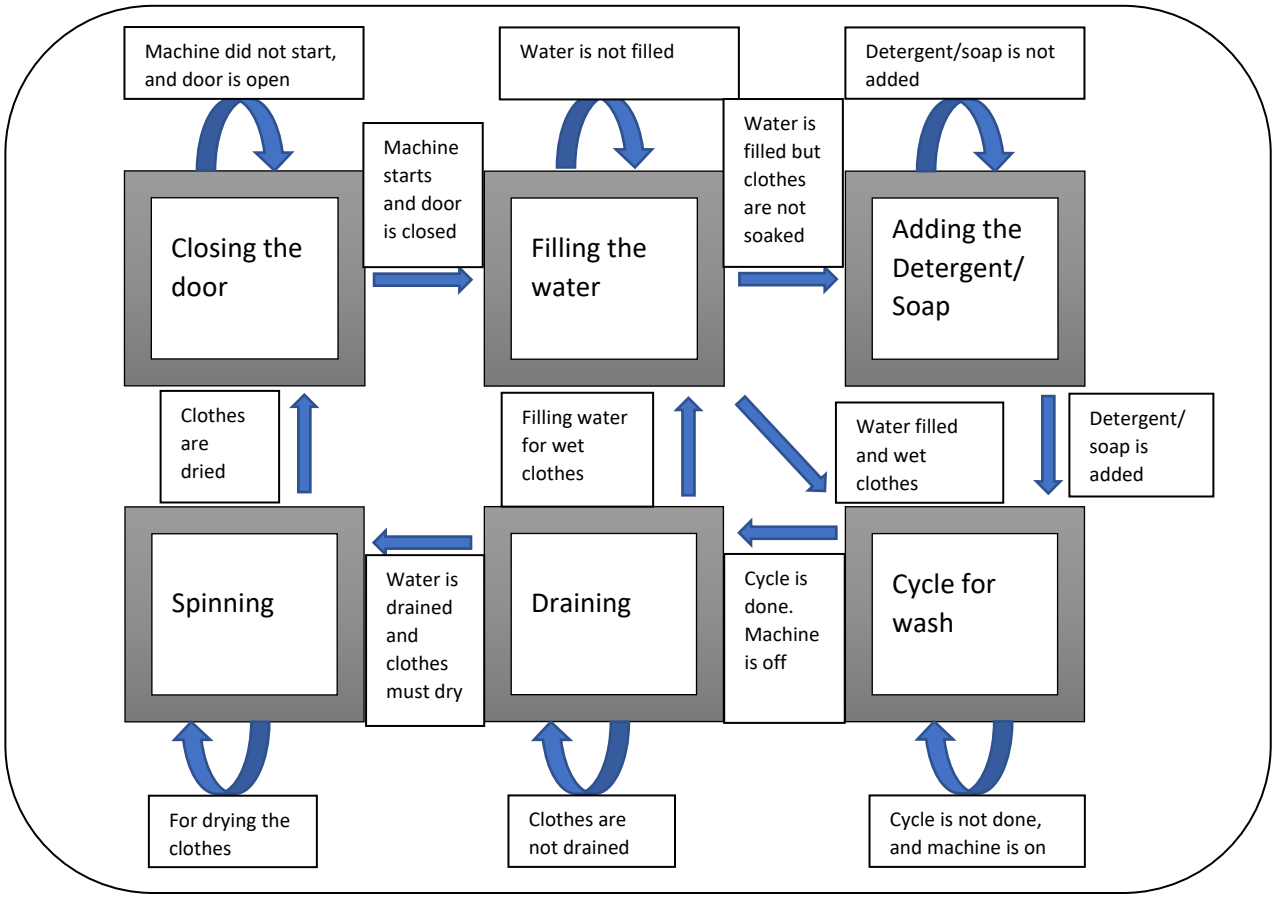
Description:

As Finite State Machines are used to create many real-life appliances, as a part of it we have implemented the design of the washing machine which used 6 finite states. The 6 finite states are as follows

- Closing the door:
    - Washing machine starts when the door is closed and locked.
- Filling the water:
    - Washing machine is filled with water which is used for soaking the clothes.
- Adding detergent/soap:
    - Washing machine uses detergent/soap to clean and wash the clothes.
- Cycle for wash:
    - Cycle for wash is used by the washing machine to wash the clothes for certain time.
- Draining:
    - Wet clothes will be drained after washing and cleaning them.
- Spinning:
    - Spinning is used for drying the wet clothes.

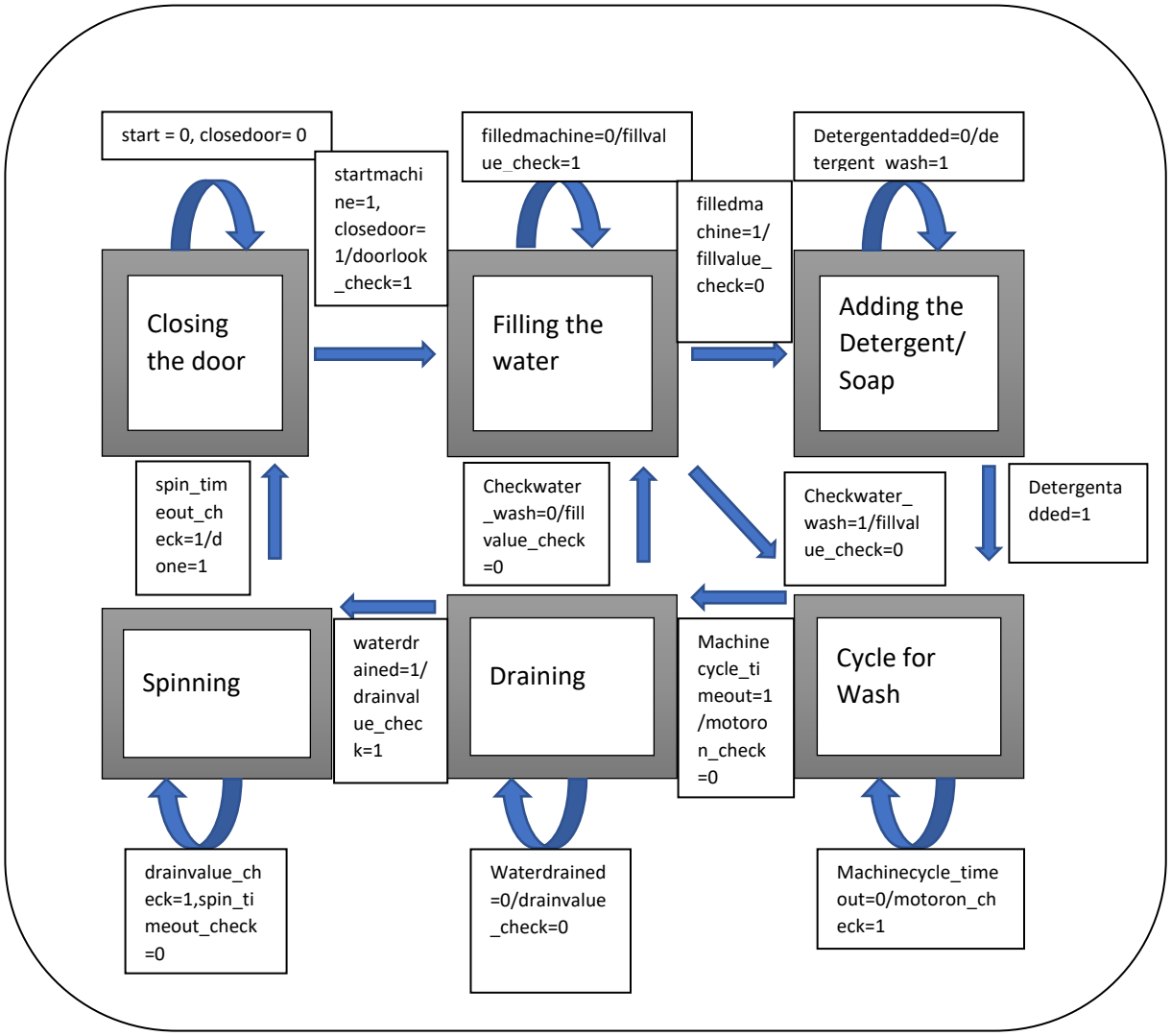
There are 9 inputs and 7 outputs in this finite state design. It also contains about 6 stage parameters. To toggle between the states, we have used switch case scenarios. There are additional 2 registers namely current and next states which are used in the code.

Block Diagram:

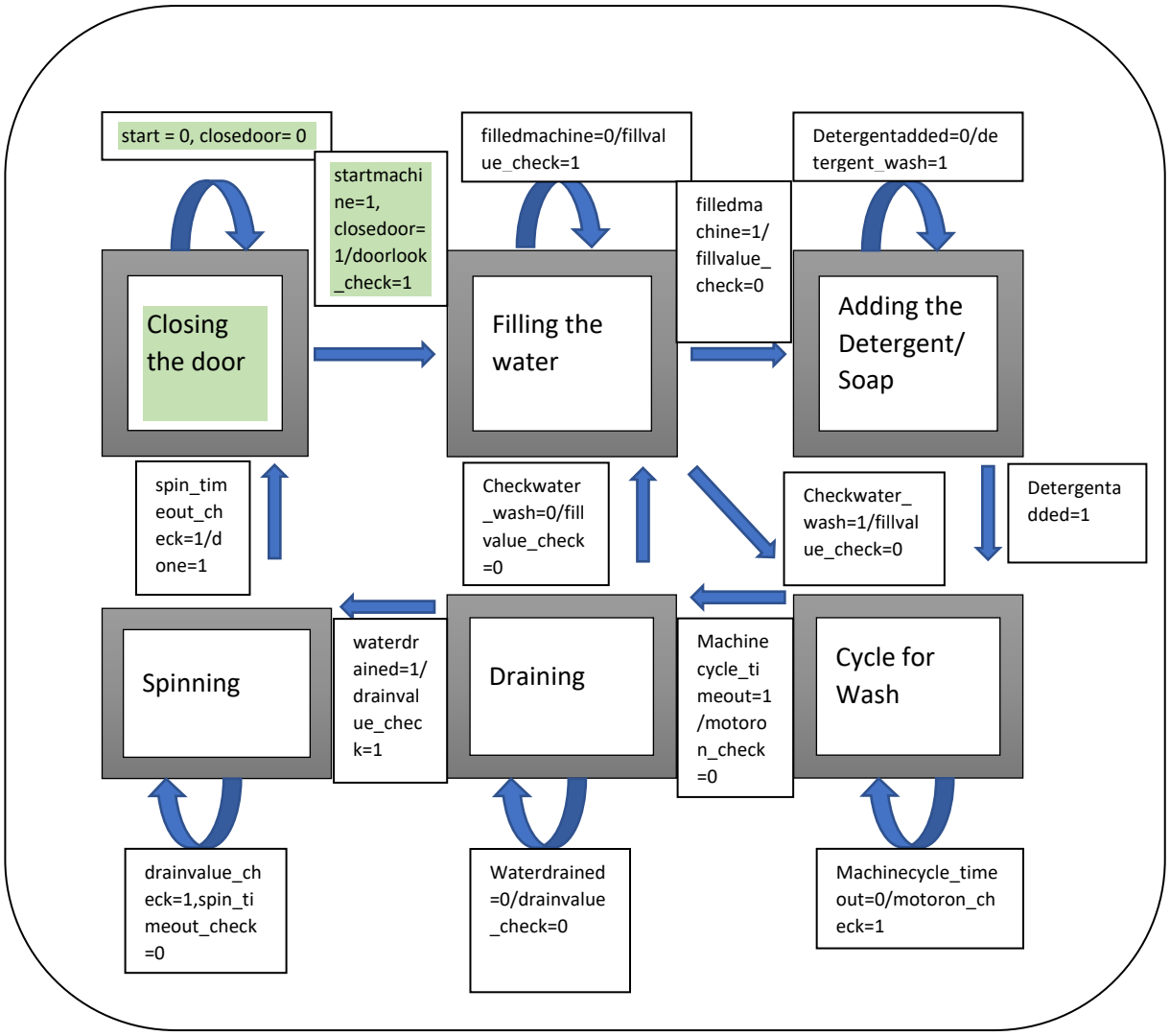


MODULE

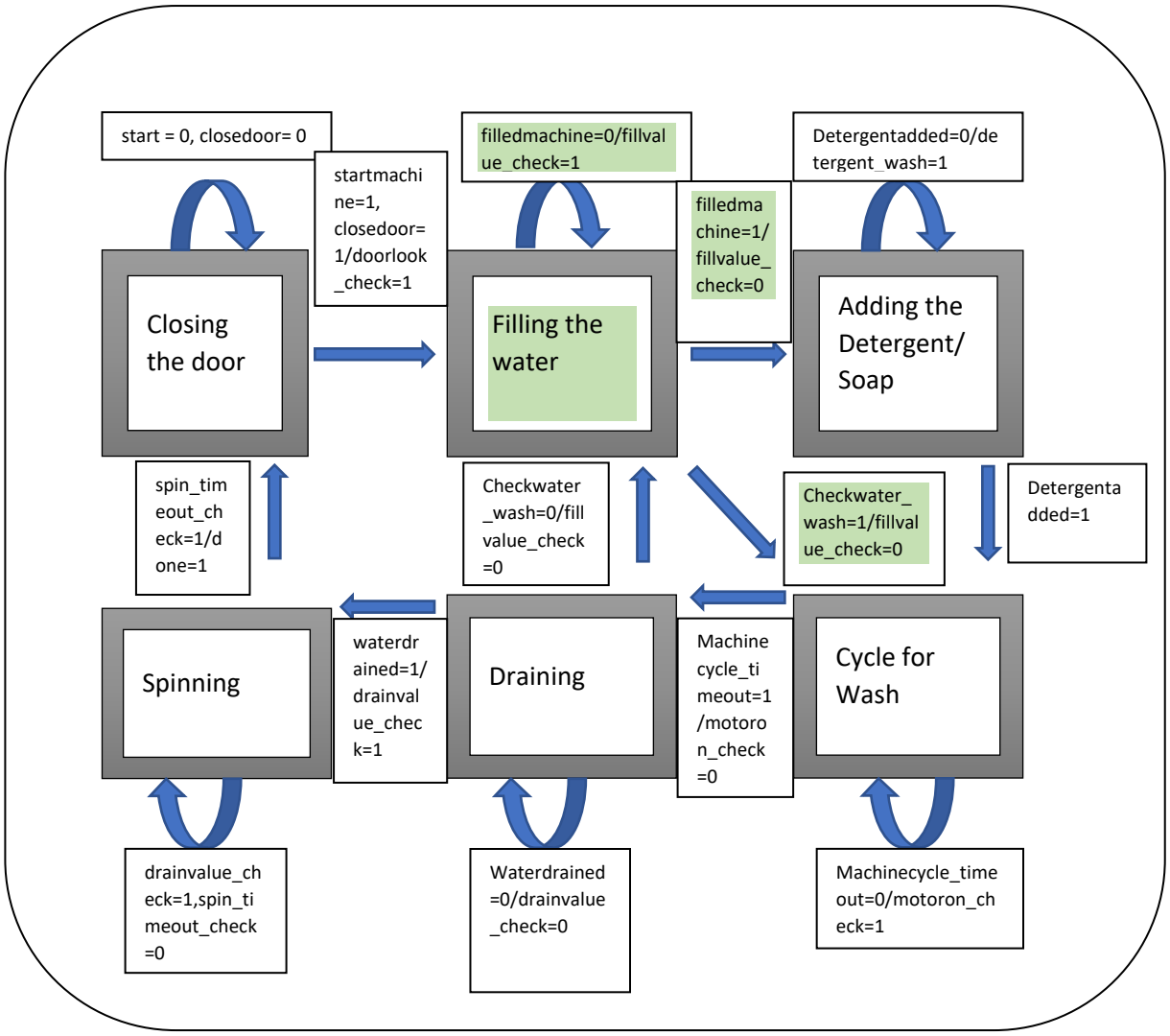
State Diagram:



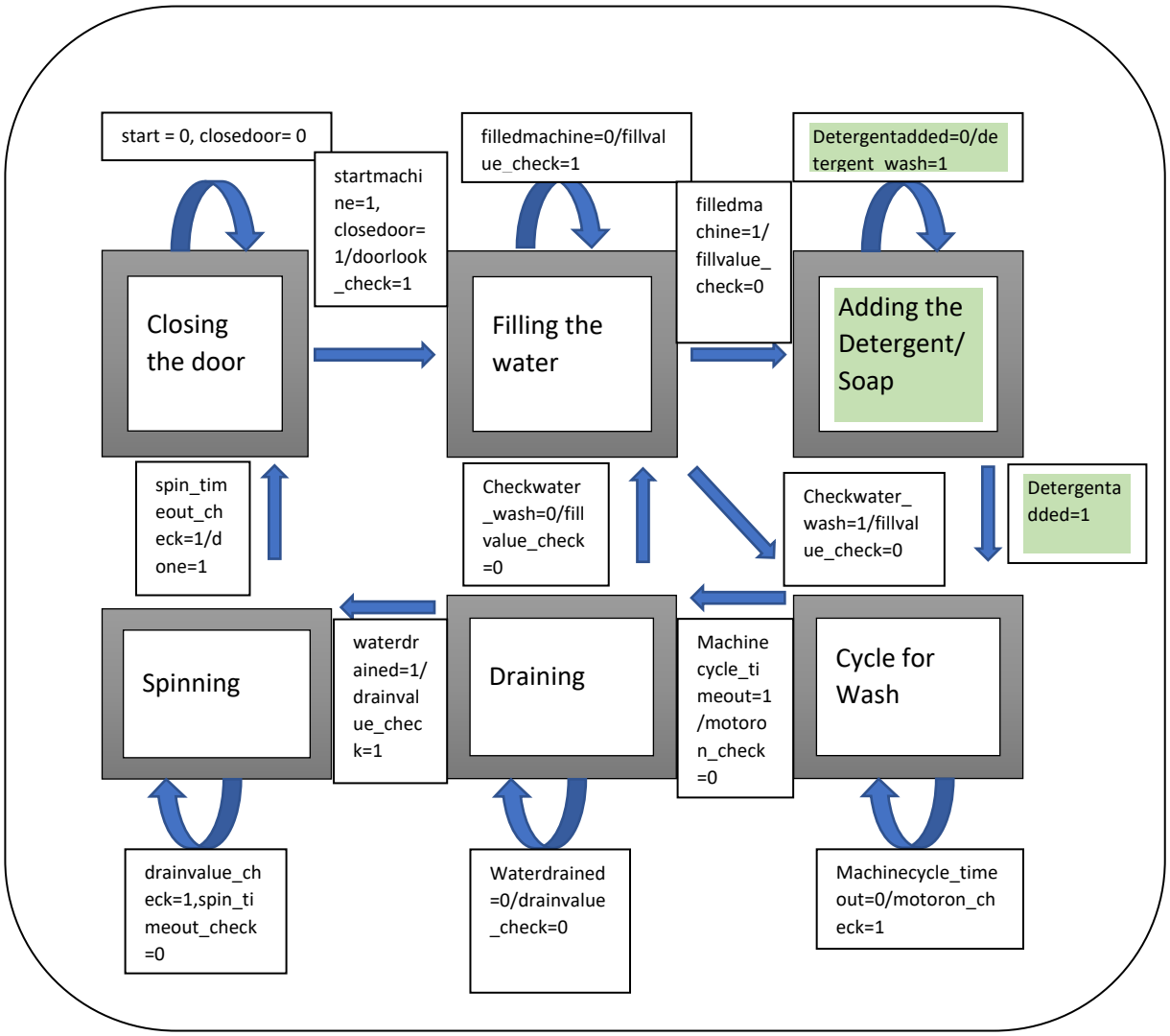
State 1: Closing the door



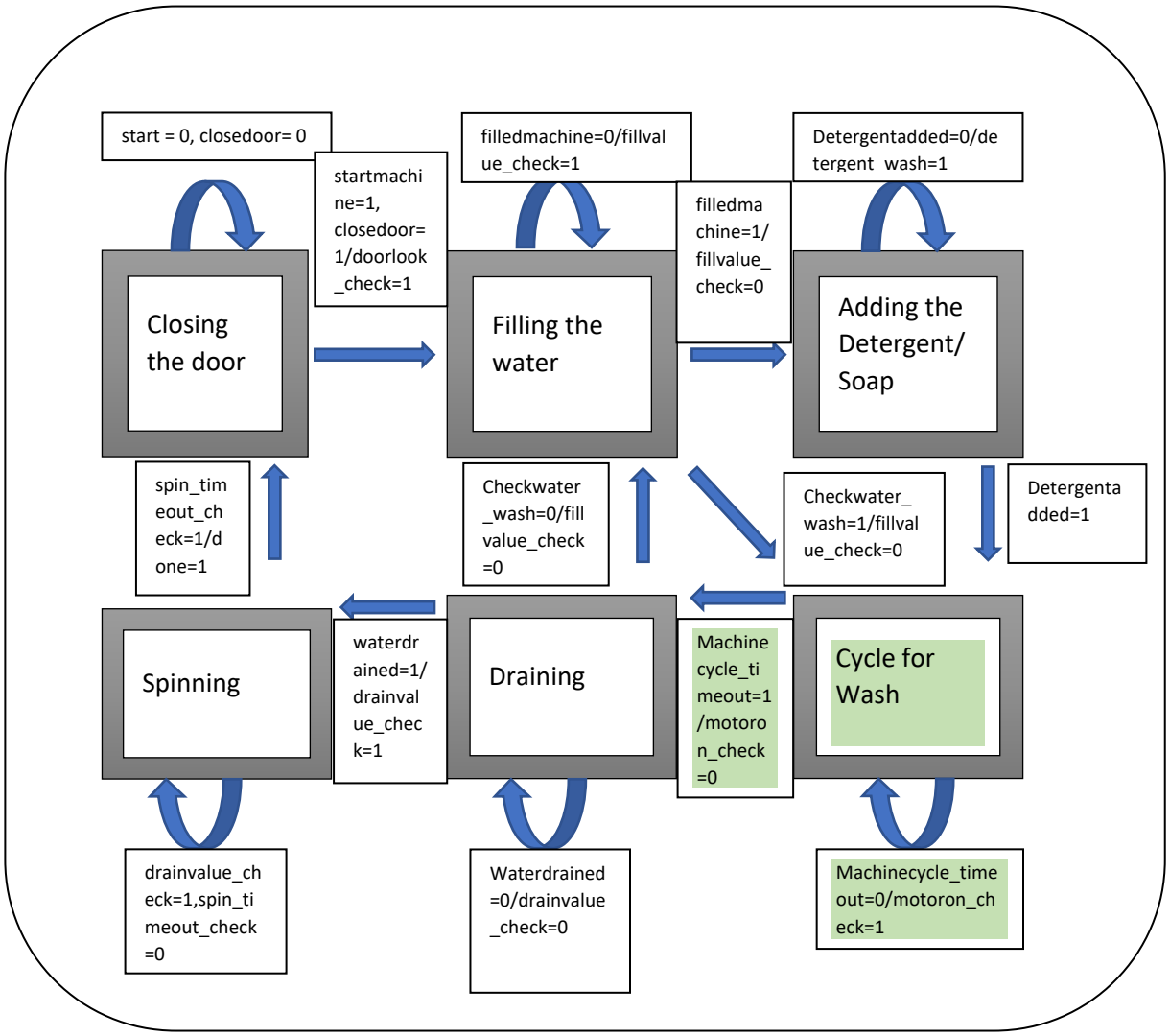
State2: Filling the water



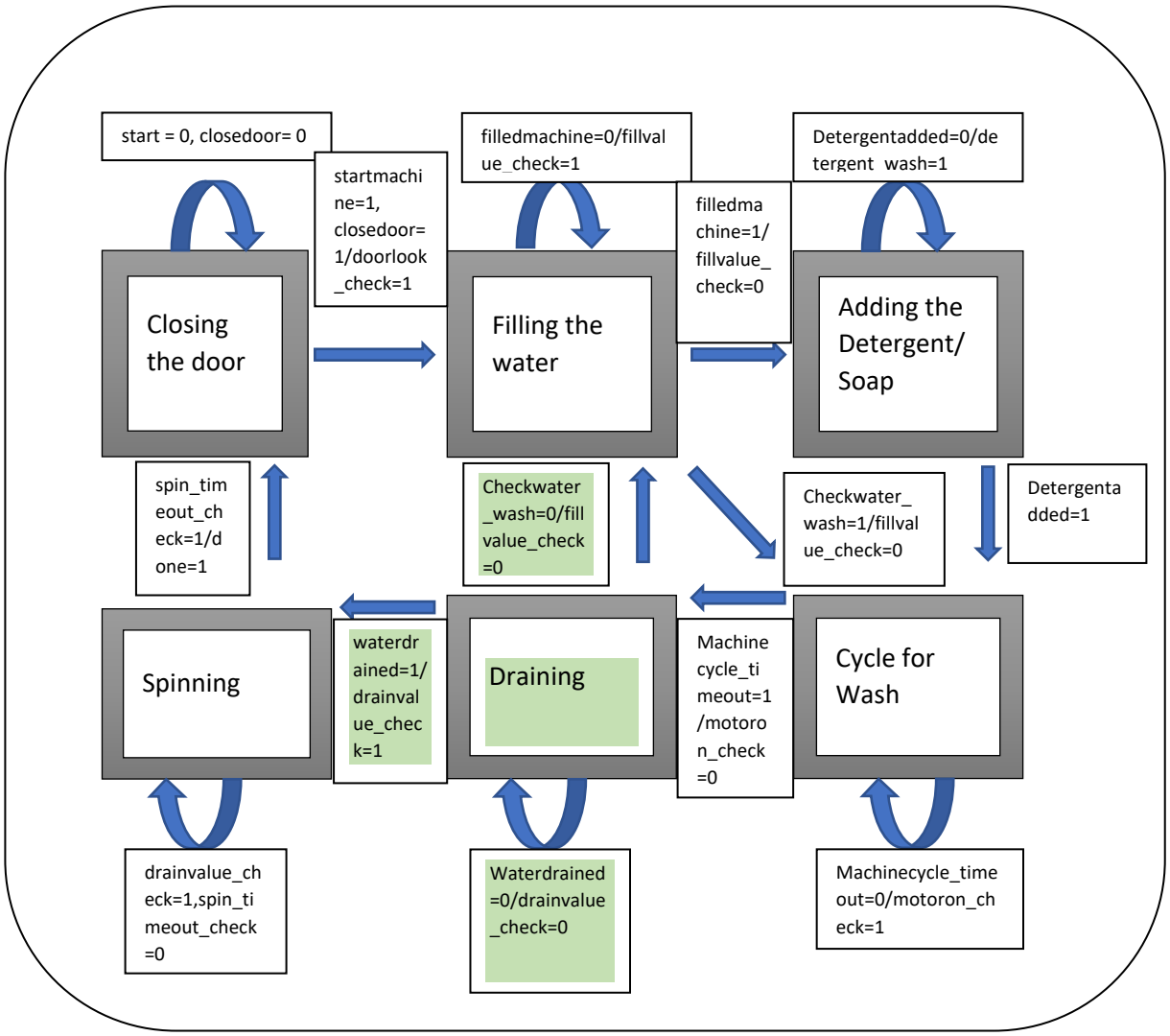
State3: Adding the Detergent/Soap



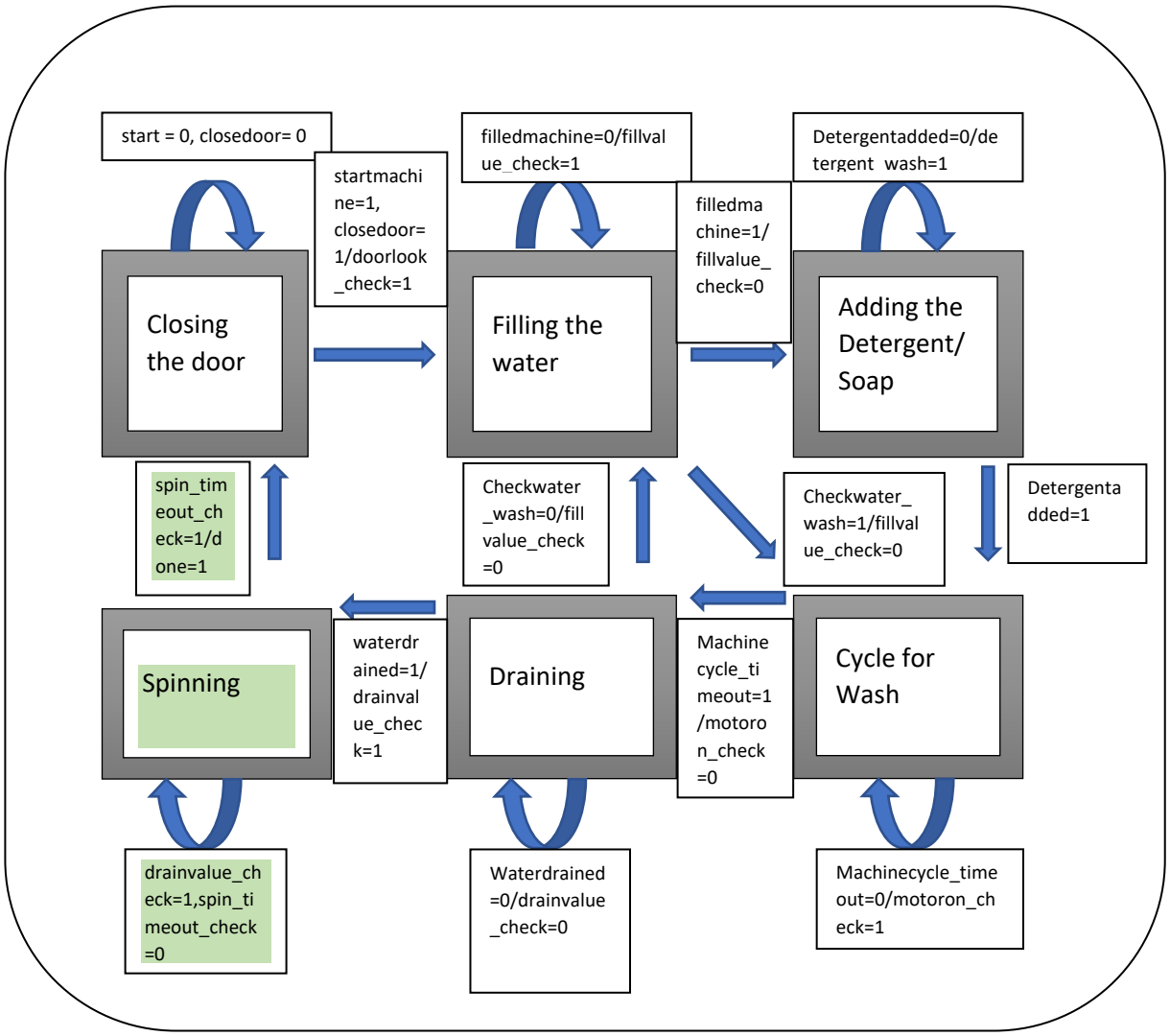
State4: Cycle for Wash



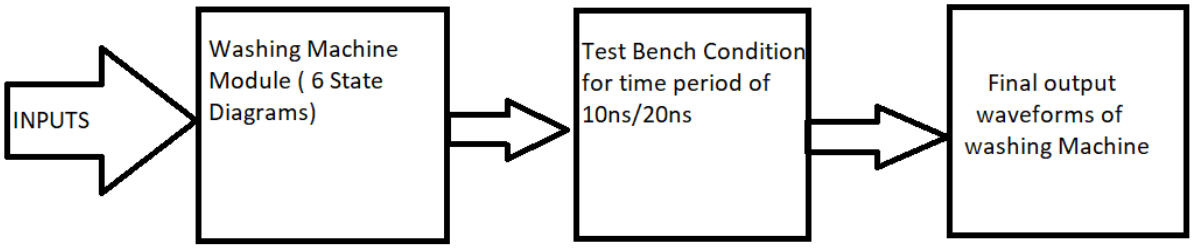
State5: Draining



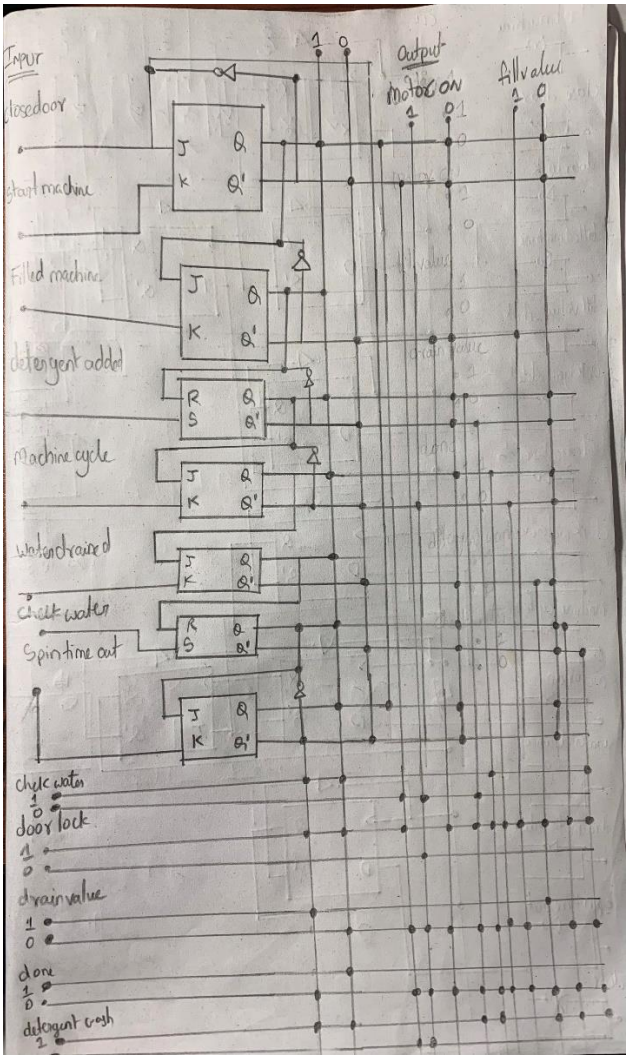
State6: Spinning



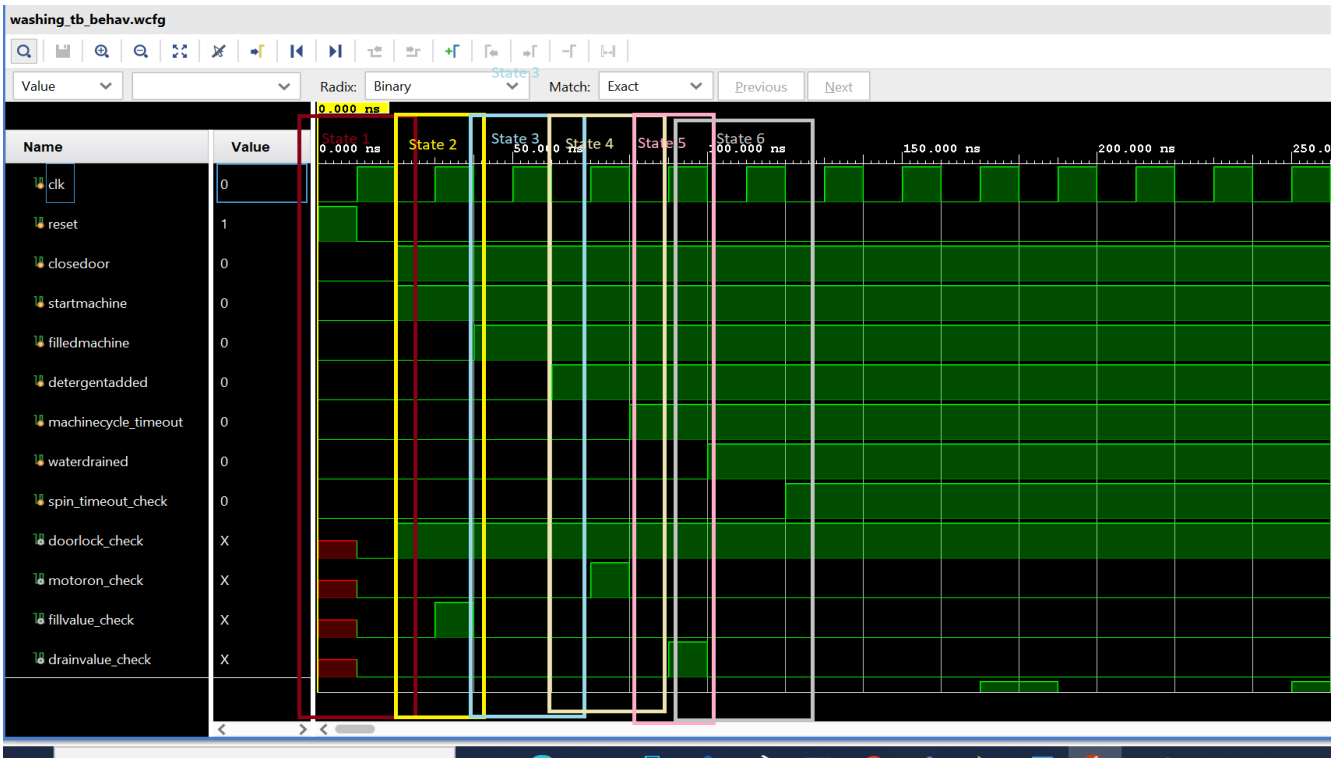
Block Diagram including testbench:



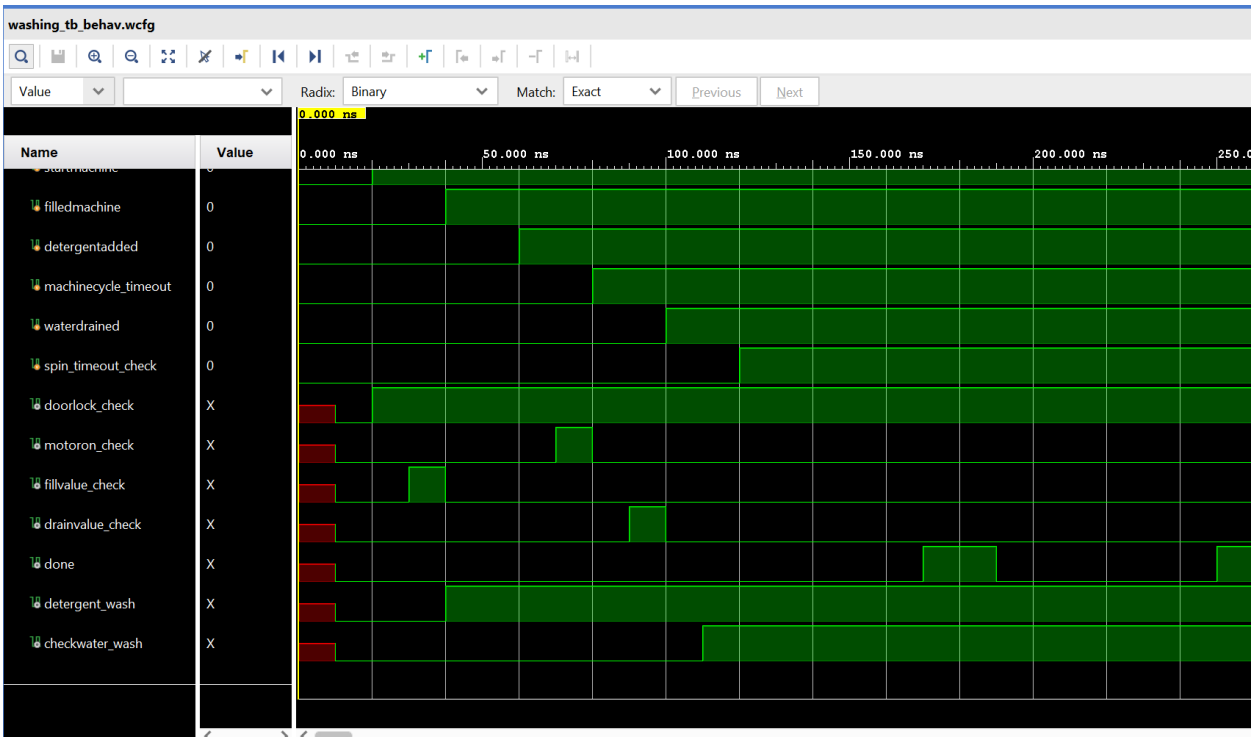
Flipflop Diagram:



Output Waveforms:



To be continued



Code Used:

Module:

```
`timescale 1ns / 1ps

//////////////////////////////////////////////////////////////////////////////////

// Module Name: washingmachine

//////////////////////////////////////////////////////////////////////////////////



module washingmachine(clk, reset, closedoor, startmachine, filledmachine, detergentadded,machinecycle_timeout, waterdrained, spin_timeout_check, doorlock_check, motoron_check, fillvalue_check, drainvalue_check, done,

detergent_wash, checkwater_wash);

  input clk, reset, closedoor, startmachine, filledmachine, detergentadded, machinecycle_timeout, waterdrained,spin_timeout_check;

  output reg doorlock_check, motoron_check, fillvalue_check, drainvalue_check, done, detergent_wash, checkwater_wash;



  //defining the states


  parameter checkdoor = 3'b000;

  parameter fillwater = 3'b001;

  parameter detergentadder = 3'b010;

  parameter cycling = 3'b011;

  parameter waterdraining = 3'b100;

  parameter spinning = 3'b101;

  reg[2:0] currentstatecheck, nextstatecheck;


  always@(currentstatecheck or startmachine or closedoor or filledmachine or detergentadded or waterdrained or

  machinecycle_timeout or spin_timeout_check)

  begin

  case(currentstatecheck)


  //checking the door if it is locked and closed.

  //machine is started at this stage.
```

```
checkdoor:
if(startmachine==1 && closedoor==1)
begin
   nextstatecheck = fillwater;
   motoron_check = 0;
   fillvalue_check = 0;
   drainvalue_check = 0;
   doorlock_check = 1;
   detergent_wash = 0;
   checkwater_wash = 0;
   done = 0;
end
else
begin
   nextstatecheck = currentstatecheck;
   motoron_check = 0;
   fillvalue_check = 0;
   drainvalue_check = 0;
   doorlock_check = 0;
   detergent_wash = 0;
   checkwater_wash = 0;
   done = 0;
end

//Water is filled for soaking the clothes.
fillwater:
if (filledmachine==1)
begin
if(detergent_wash == 0)
begin
   nextstatecheck = detergentadder;
   motoron_check = 0;
   fillvalue_check = 0;
```

```
        drainvalue_check = 0;
        doorlock_check = 1;
        detergent_wash = 1;
        checkwater_wash = 0;
        done = 0;
    end
    else
    begin
        nextstatecheck = cycling;
        motoron_check = 0;
        fillvalue_check = 0;
        drainvalue_check = 0;
        doorlock_check = 1;
        detergent_wash = 1;
        checkwater_wash = 1;
        done = 0;
    end
    end
    else
    begin
        nextstatecheck = currentstatecheck;
        motoron_check = 0;
        fillvalue_check = 1;
        drainvalue_check = 0;
        doorlock_check = 1;
        done = 0;
    end

//detergent/soap will be added.
    detergentadder:
    if(detergentadded==1)
    begin
        nextstatecheck = cycling;
```

```
    motoron_check = 0;
    fillvalue_check = 0;
    drainvalue_check = 0;
    doorlock_check = 1;
    detergent_wash = 1;
    done = 0;
end
else
begin
    nextstatecheck = currentstatecheck;
    motoron_check = 0;
    fillvalue_check = 0;
    drainvalue_check = 0;
    doorlock_check = 1;
    detergent_wash = 1;
    checkwater_wash = 0;
    done = 0;
end

//Washing cycle for the cleaning the clothes
cycling:
if(machinecycle_timeout == 1)
begin
    nextstatecheck = waterdraining;
    motoron_check = 0;
    fillvalue_check = 0;
    drainvalue_check = 0;
    doorlock_check = 1;
    //detergent_wash = 1;
    done = 0;
end
else
begin
```

```
    nextstatecheck = currentstatecheck;
    motoron_check = 1;
    fillvalue_check = 0;
    drainvalue_check = 0;
    doorlock_check = 1;
    //detergent_wash = 1;
    done = 0;
  end

  //draining the water from wet clothes
  waterdraining:
  if(waterdrained==1)
  begin
  if(checkwater_wash==0)
  begin
    nextstatecheck = fillwater;
    motoron_check = 0;
    fillvalue_check = 0;
    drainvalue_check = 0;
    doorlock_check = 1;
    detergent_wash = 1;
    //checkwater_wash = 1;
    done = 0;
 end
 else
 begin
    nextstatecheck = spinning;
    motoron_check = 0;
    fillvalue_check = 0;
    drainvalue_check = 0;
    doorlock_check = 1;
    detergent_wash = 1;
    checkwater_wash = 1;
```

```
    done = 0;
end
end
else
begin
    nextstatecheck = currentstatecheck;
    motoron_check = 0;
    fillvalue_check = 0;
    drainvalue_check = 1;
    doorlock_check = 1;
    detergent_wash = 1;
    //checkwater_wash = 1;
    done = 0;
 end

 //drying the clothes which are drained.
 spinning:
 if(spin_timeout_check==1)
 begin
    nextstatecheck = closedoor;
    motoron_check = 0;
    fillvalue_check = 0;
    drainvalue_check = 0;
    doorlock_check = 1;
    detergent_wash = 1;
    checkwater_wash = 1;
    done = 1;
 end
 else
 begin
    nextstatecheck = currentstatecheck;
    motoron_check = 0;
    fillvalue_check = 0;
```

```
            drainvalue_check = 1;
            doorlock_check = 1;
            detergent_wash = 1;
            checkwater_wash = 1;
            done = 0;
        end
        default:
        nextstatecheck = checkdoor;
       endcase
       end
       always@(posedge clk or negedge reset)
       begin
        if(reset)
        begin
        currentstatecheck<=3'b000;
        end
        else
        begin
            currentstatecheck<=nextstatecheck;
        end
    end
endmodule
```

Test Bench:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Module Name: washing_tb
//////////////////////////////////////////////////////////////////////////////////


module washing_tb();
    reg clk, reset, closedoor, startmachine, filledmachine, detergentadded, machinecycle_timeout, waterdrained, spin_timeout_check;
    wire doorlock_check, motoron_check, fillvalue_check, drainvalue_check, done, detergent_wash, checkwater_wash;

    washingmachine machine1(clk, reset, closedoor, startmachine, filledmachine, detergentadded,machinecycle_timeout, waterdrained, spin_timeout_check, doorlock_check, motoron_check, fillvalue_check, drainvalue_check, done,detergent_wash, checkwater_wash);
  initial
  begin
    clk = 0;
    reset = 1;
    startmachine = 0;
    closedoor = 0;
    filledmachine = 0;
    waterdrained = 0;
    detergentadded = 0;
    machinecycle_timeout = 0;
    spin_timeout_check = 0;
    #10 reset=0;
    #10 startmachine=1;closedoor=1;
    #20 filledmachine=1;
    #20 detergentadded=1;
    #20 machinecycle_timeout=1;
    #20 waterdrained=1;
    #20 spin_timeout_check=1;
  end
```

```
    always
    begin
        #10 clk = ~clk;
    end
endmodule
```

Conclusion:

We have successfully created a washing machine using Verilog. Additional features like setting up cloth material, spin time adjustments, wash time adjustments, water temperature, etc. can be implemented in order to make the machine more efficient.